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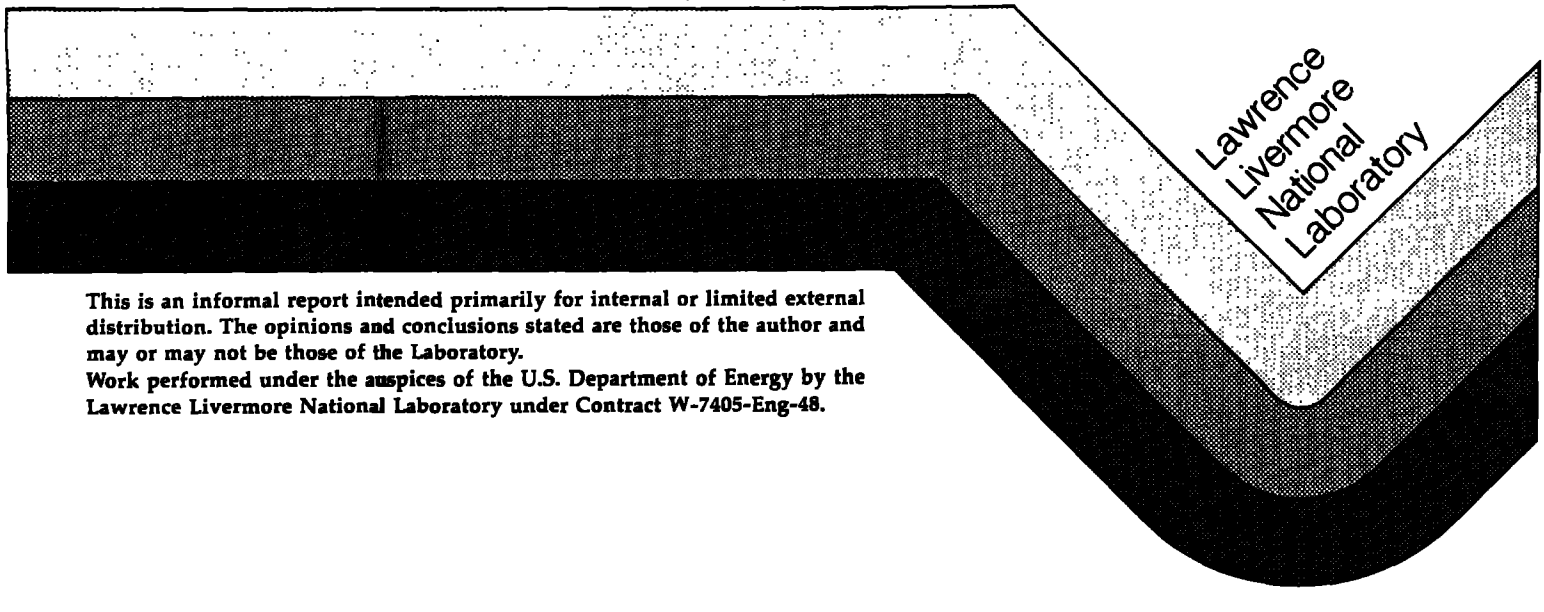
ANTI-ABRASION PROTECTION WITH HIGHLY ORGANIZED MATERIALS

Multiyear Program Plan

William A. Steele

August 8, 1986



Work performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

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I. BACKGROUND

Highly organized structures on a surface can be used to produce a high degree of abrasion resistance. A compliant coating can be made out of hard, brittle ceramics by embedding them as high aspect ratio fibers into the surface to be protected. This hairlike coating then provides substantial impact and abrasion resistance in an easily fabricated surface.

Fabrication procedures and optimization of the structures will now be investigated. The use of a number of different fiber and matrices to achieve structures compatible with different temperature ranges will be undertaken. The resulting materials will be tested for abrasion and impact resistance over a range of loads. Highly dense structures will be used to maximize the strength of the base composite.

II. PRIOR AND CURRENT ACTIVITIES

The continuing optimization effort is being carried out to optimize the length, orientation, packing density and buried fraction. Composites is being examined microscopically, tested for adhesion and bending fracture. Assembled test pieces is being checked for abrasion resistance using sandblasting and bead blasting in various orientations and various particle sizes. A number of different fiber materials is being examined. These include carbon/graphite fibers in a polymer matrix, nickel coated graphite fibers in high purity aluminum and alumina fibers in alumina and steel. Zirconium oxide fibers in a cast alumina matrix can be used as a high temperature ceramic model system. Experimental quantities of alumina and zirconia fibers have been secured.

For initial proof of concept, carbon fibers were partially embedded in epoxy resins. This procedure gave us the option of controlling the fiber packing density and the length of exposed nap. Once the optimum packing density and length of nap were established, the MCI Company was able to perform a squeeze cast metal intrusion experiment to provide us

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with an aluminum/carbon fiber specimen. MCI is presently attempting to produce an aluminum plate with embedded carbon fibers. This plate will then be rolled or formed into a cylinder or pipe to be open at both ends and sealed along the seam by laser or electron beam welding.

III. FUTURE ACTIVITIES

Future efforts will be directed simultaneously toward the development of a more reproducible ceramic fiber and casting techniques and the advancement of the carbon/graphite fiber with various coatings and different metal matrices.

We look forward with great optimism to the application of this technology in the development and mass production technology of impact resistant jet engine turbine blades. In addition, we foresee the development and fabrication of slurry pipelines for coal transportation and overcoming the severe conventional constraints on existing structural materials.

Milestone Schedule